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Six Sigma: Definition and underlying theory☆

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Abstract

Six Sigma has been gaining momentum in industry; however, academics have conducted little research on this emerging phenomenon. Understanding Six Sigma first requires providing a conceptual definition and identifying an underlying theory. In this paper we use the grounded theory approach and the scant literature available to propose an initial definition and theory of Six Sigma. Our research argues that although the tools and techniques in Six Sigma are strikingly similar to prior approaches to quality management, it provides an organizational structure not previously seen. This emergent structure for quality management helps organizations more rigorously control process improvement activities, while at the same time creating a context that enables problem exploration between disparate organizational members. Although Six Sigma provides benefits over prior approaches to quality management, it also creates new challenges for researchers and practitioners.

Keywords: Quality management; Six Sigma; Organizational issues; Case/field study

All truth passes through three stages. First, it is ridiculed. Second, it is violently opposed. Third, it is accepted as being self-evident.

Arthur Schopenhauer

1. Introduction

Six Sigma has been characterized as the latest management fad to repackage old quality management principles, practices, and tools/techniques (Clifford, 2001). At first glance Six Sigma looks strikingly similar to prior quality management approaches. However, leading organizations with a track record in quality have adopted Six Sigma and claimed that it has transformed their organization. For example, 3M's Dental Division won the Baldrige Award (Aldred, 1998) and then later adopted Six Sigma to improve performance even further (McClenahen, 2004). The financial performance of 3M since Six Sigma adoption has been very impressive (Fiedler, 2004). Other organizations with a quality track record, such as Ford, Honeywell, and American Express, have adopted Six Sigma as a way to further enhance business performance (Hahn et al., 2000). This creates a dilemma: on the one hand, skeptics argue that Six Sigma lacks discriminate validity over prior approaches to quality management; on the other hand, quality-mature organizations adopt Six Sigma to enhance performance.

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Scholarly inquiry into this management approach has been limited. While many books and papers on Six Sigma have emerged in the practitioner literature (Breyfogle, 1999; Harry and Schroeder, 2000; Pande et al., 2000), academic research on Six Sigma is just beginning to come forward. Scholarly research is needed to develop an in-depth, scientific understanding of Six Sigma and separate fact from fiction.

This paper finds that indeed the philosophy and tools/techniques of Six Sigma are strikingly similar to prior quality management approaches. However, the way Six Sigma is practiced represents a new organization structural approach to improvement. Six Sigma helps an organization become more ambidextrous by providing a *switching structure* (Daft, 2001) that allows the organization to act more *organically* in coming up with new improvement ideas and operate more *mechanistically* when implementing them. Furthermore, the structure of Six Sigma employs numerous mechanisms that simultaneously promote the conflicting demands of *exploration* and *control* in the improvement effort. As a result, what is new in Six Sigma when compared to prior quality management approaches is more its organizational implementation rather than the underlying philosophy or the quality tools/techniques employed.

At this early stage in the development of scientific knowledge about Six Sigma, academic research needs to address three questions:

1. What is the base definition of Six Sigma and possible variants?
2. What is the theoretical basis underlying Six Sigma?
3. What is new about Six Sigma relative to the existing literature?

Our research addresses these questions using a grounded theory approach. This approach helps develop an in-depth, relevant understanding of poorly understood phenomena (Eisenhardt, 1989; Meredith, 1998; Yin, 1994). Since no clear definition or theory has emerged to explain Six Sigma, conceptual development can take place by using field observation, the literature, and/or pure thought. This paper employs all three approaches to provide a solid basis for the emergent theory development and subsequent testing.

After discussing the literature in the next section, we define Six Sigma from our grounded theory research and propose an underlying theory for Six Sigma. We then address what is new and propose some future research directions. The result in a grounded theory that has potential value for advancing the scientific understanding of Six Sigma.

2. The literature

Motorola originally developed Six Sigma in 1987 and targeted an aggressive goal of 3.4 ppm defects (Barney, 2002b; Folaron, 2003). In 1994 Larry Bossidy, CEO of AlliedSignal, introduced Six Sigma as a business initiative to "produce high-level results, improve work processes, expand all employees' skills and change the culture" (ASQ, 2002, p. 14). This was followed by the well-publicized implementation of Six Sigma at General Electric beginning in 1995 (Slater, 1999).

Currently, there are many books and articles on Six Sigma written by practitioners and consultants and only a few academic articles published in scholarly journals (Linderman et al., 2003, 2004). Reviewing the practitioner literature and these academic articles provides a starting point for defining Six Sigma.

Six Sigma has been defined in the practitioner literature in a variety of ways. This disparity leads to some uncertainty and confusion. Consider some of the following definitions from the practitioner articles. *Quality Progress* called Six Sigma a "high-performance, data-driven approach to analyzing the root causes of business problems and solving them" (Blakeslee, 1999, p. 78). Harry and Schroeder (2000), in their popular book on Six Sigma, described it as a "business process that allows companies to drastically improve their bottom line by designing and monitoring everyday business activities in ways that minimize waste and resources while increasing customer satisfaction" (p. vii). Hahn et al. (2000) described Six Sigma as a disciplined and statistically based approach for improving product and process quality. On the other hand, Sanders and Hild (2000) called it a management strategy that requires a culture change in the organization. Recognizing the divergence in definitions, Hahn et al. (1999) noted that Six Sigma has not been carefully defined in either the practitioner or academic literature.

Many of the definitions of Six Sigma found in the literature are very general and do not provide elements—or factors (variables, constructs, concepts), as Whetten (1989) described them—to define the "what" of the theory, nor do they describe relationships among the elements to define the "how." Therefore, our data collection focused on obtaining a scientific definition of Six Sigma and then extracting both the elements of Six Sigma and their relationships.

3. Field data and analysis

In order to develop a rich understanding of Six Sigma we selected two corporations that had implemented it,

one in manufacturing and the other in service (hereafter referred to as MFG and SERV, respectively). These two companies were selected using the idea of theoretical sampling (Eisenhardt, 1989) to inform the theory we are developing. They were in two different industries, and one had just started implementing Six Sigma, while the other had extensive experience with it. We seek theoretical sampling in theory building rather than the generalizability sought in statistical studies, so the cases were chosen for theoretical rather than statistical reasons. In some cases, polar opposites are selected to inform and expand the emergent theory (Eisenhardt, 1989). While the cases we selected were not polar opposites, they provide enough differences to support the development of an emergent theory that can potentially apply across industries and to different stages of implementation maturity.

Four projects were selected from each company: two that were representative of the best results obtained and two that had less successful results. These projects were not selected randomly; they were selected to help improve our understanding of Six Sigma. Furthermore, studying two very different companies and several projects should improve the richness of our findings.

MFG is a large manufacturing company (with multi-billions of dollars in revenue) that produces electronic components for the computer industry. They have been using Six Sigma for 3 years and are very advanced in its application. MFG has almost 3.5% of its professional workforce (about 350 out of 10,000 full-time employees) working as full-time Black Belt specialists, and they have completed over 1000 Six Sigma projects. MFG has documented savings of over $400 million from its Six Sigma efforts.

SERV is a large (billion-dollar-plus) service company providing computer software services to its customers. It is a well-established business but has been implementing Six Sigma at a slow pace. Only a small number of Black Belts have been trained, and only a few projects had been completed at the time of this study.

In each company our research team interviewed corporate officers in addition to individuals associated with each of the projects. The corporate officers were generally in charge of Six Sigma efforts and were at the vice president or director level. We also interviewed Black Belt specialists, Green Belts, and Master Black Belts who had worked on each of the projects and often reported to Project Champions (operating vice presidents) who were in charge of the particular processes being studied. We conducted 22 interviews lasting from 1 to 2 hours each.

In each company we asked interviewees a series of questions. At the corporate level we asked questions about the history of Six Sigma deployment in the company, the company's definition of Six Sigma, the approach used, what they thought was new about Six Sigma compared to previous quality approaches, top management support, and the training and benefits of Six Sigma. We also asked extensive questions about knowledge creation, diffusion, and retention as a result of Six Sigma projects; however, this part of the interview is outside the scope of the present paper.

The interviews at the project level followed a similar format, starting with a description of the origin of the specific project, followed by a description of the project team and method used, an explanation of benefits and costs, an update on what is new, and an overview of the learning that occurred from the project. We also asked about knowledge created, diffused, and retained from the project.

All of the interviews were tape recorded with the permission of the respondent on a confidential basis and then transcribed after the meeting. The transcriptions were entered into NUD*IST, a software program that permits analysis and manipulation of qualitative data (Gahan and Hannibal, 1998). Each transcript was coded according to the key issues discussed by the informants. The codes were subsequently used to extract data and quotations for analysis.

In an effort to triangulate our research results, as recommended by Jick (1979), we also collected the following types of written materials from each company:

- training manuals;
- briefings on Six Sigma;
- articles written about the company on Six Sigma;
- annual reports pertaining to Six Sigma;
- reports on financial savings, number of people trained, etc.;
- story boards for individual projects;
- minutes of project meetings;
- presentations made to management;
- other documents describing Six Sigma.

The researchers who conducted the interviews then analyzed these materials to supplement the responses obtained from the interviewees. This approach reinforced statements made during the interviews or helped identify discrepancies that served as a basis for further inquiry.

In line with qualitative research procedures, the research team conducted a number of meetings to distill

the important findings and conclusions from the field data (Eisenhardt, 1989; Miles and Huberman, 1994; Yin, 1994). Prior to these meetings the researchers read the transcripts and came prepared to discuss definitions of Six Sigma, its constructs, relationships and important research issues that could be developed further. We first conducted within-case analyses to insure that all researchers had the same understanding of the interviews and written information. Then we conducted cross-case analyses to further understand differences and similarities observed. After these meetings, team members conducted additional analyses of the transcripts and written documents to support or refute the tentative conclusions.

4. Definition of Six Sigma

In order to develop a definition of Six Sigma, we draw upon the field data we collected and then compare it to the literature. We begin by presenting a number of definitions offered to us during the interviews. Finally, we will present an emergent theoretical definition based on the interviews and the literature.

Note that in each interview the respondent was specifically asked to provide a definition of Six Sigma, which was then discussed and clarified with them. For example, two top executives interviewed at MFG defined Six Sigma as follows:

> For us, you take from among your best people, give them 4 weeks of problem-solving discipline skills, you tie them to one of your most leveraged problems that if you fix this it generates a lot of return, you give them full time to lead a team to go get this thing done, and you have active support of senior management, and that's what Six Sigma to us is all about. But, if you boil it down to our view is we want to improve the pace of improvement so that we are significantly ahead of our competition, whomever that might be. So if you can learn faster and fix faster than your competition, then you will be on the way to long-term health as a company. (Executive 1)

> What's different about six sigma from my perspective is number one you're taking people out of their full-time jobs . . . we're teaching them how to solve a problem using statistics and methods. And then they're [Black Belts] assigned to work with a Champion, a Champion typically is a vice president, who ideally or hopefully understands what's really impacting the business and will pick a tough problem for that Black Belt to work on. (Executive 2)

These executives viewed Six Sigma in very broad terms as an approach to running a business that leads to competitive advantage. These are not efficiency-oriented definitions, although savings are important at MFG. They also noted the importance of connecting the Black Belt with a Champion to ensure Six Sigma teams work on processes important to the business strategy. This definition refers to how the business is run rather than process improvement or statistical methods.

A Black Belt in SERV defined Six Sigma as follows:

> As far as Six Sigma goes, there's a couple of different ways of looking at it from my perspective. One is more of the technical aspect, where you're looking at the first time yield or the defects per million opportunities. That's one way of looking at it. The way I tend to describe it to people that I work with in business . . . is looking at a situation, identifying if there's a problem, and then drilling down into the root cause. What companies tend to do is they tend to attack these symptoms and when they attack a symptom they may fix that little problem but there are still all these other problems. When you drill down to the root cause, you not only resolve the symptom you were originally looking at but numerous other problems at the same time. . . So to me it's a way of improving processes using a very logical, sound method. It's the right way to do business.

This definition emphasizes the idea of getting to the root cause of problems in order to improve a process. This is very important because there is a tendency to jump to conclusions and to attack symptoms rather than the underlying problems in business.

Another Black Belt in SERV also noted the importance of the Champion in Six Sigma:

> And then besides that, it's also re-checking now and then with the project Champion, making sure we're on track. Sometimes you've got to look at it and say, "Okay, where are we going? Do we need to refocus this project a little bit?" Just make sure you're still going off in the right direction.

Each of these definitions indicates somewhat different views of Six Sigma. This diversity in emphasis and points of view exists even within the same company.

From a practitioner's perspective different definitions may be considered valid, and which one is preferred may depend on the individual interviewed, the company, or the author's prior experience. However, scholars need to develop rigorous conceptual definitions that can serve as the basis of theory building (Wacker,

2004). Commonly used definitions are insufficient for scientific investigation (Teas and Palan, 1997). Conceptual definitions should show evidence of inclusivity, exclusivity, differentiability, clarity, communicability, consistency, and parsimony (Hempel, 1970, p. 654). Wacker (2004) developed rules for constructing conceptual definitions. With those rules in mind, we propose the following rigorous base definition that captures the theoretical aspects of Six Sigma from the case study data and literature:

> Six Sigma is an organized, parallel-meso structure to reduce variation in organizational processes by using improvement specialists, a structured method, and performance metrics with the aim of achieving strategic objectives.

We do not suggest one definition for everyone. Companies may choose variations of this base definition when implementing Six Sigma in order to customize it to their situation. Later, we suggest some possible variations. Contingency theory implies that the base definition will not fit every company, but nonetheless it is a starting point for research and implementation.

5. Elements of the Six Sigma definition

The elements in our base definition of Six Sigma need further clarification. Our field research (see Appendix) and literature suggest and inform the following four relevant constructs or elements (parallel-meso structure, improvement specialists, structured method, and performance metrics).

5.1. Parallel-meso structure

Parallel structures ''are extra creations that operate outside of, and do not directly alter, an organization's normal way of operating'' (Lawler, 1996, p. 132). From this perspective Six Sigma operates as a parallel structure dedicated to improving the organization (see Fig. 1). Implementation of Six Sigma at both MFG and SERV followed the logic of a parallel structure. Both organizations employed Six Sigma teams led by Black Belts and supported by Champions who focused on improving the organization.

However, parallel structures are not new to quality management. Scholars often cite Quality Circles as an example of a parallel structure (e.g., Adler et al., 1999; Lawler, 1996). From this perspective one might argue that Six Sigma and Quality Circles are isomorphic and lack discriminate validity. However, Quality Circles have faced unique challenges in implementation (Lawler and Mohrman, 1987). Lawler (1996) noted that because ''quality circles have relatively little authority and power to implement their ideas, many of their suggestions are not implemented. There are other reasons as well, including resistance from managers who are threatened by the ideas, lack of funds, and, of course, the fact that some ideas that sound good are based on incomplete or inaccurate information'' (p. 134). Although Quality Circles allowed employees to explore problems, many organizations experienced a fundamental failure with control and authority in implementation. Six Sigma provides an emergent structural evolution in quality that can overcome some of these challenges, which can be described as a parallel-meso structure.

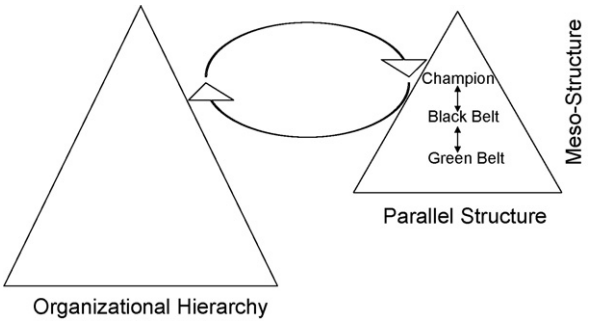

Fig. 1. Six Sigma parallel-meso structure.

''Meso theory concerns the integration of both the micro- and macro-levels of analysis. Individuals and groups affect the organization and the organization in return affects individuals and groups. To thrive in organizations, managers and employees need to understand multiple levels simultaneously'' (Daft, 2001, p. 32). Scholars have recognized Six Sigma as an example of a meso approach to work design (Sinha and Van de Ven, 2005). Barney (2002a) described Six Sigma as a ''combination of macro-organizational strategy and meso and micro-tactics.'' Six Sigma provides a hierarchical structure where leaders (Champions) initiate, support, and review key improvement projects; Black Belts then serve as project leaders who mentor Green Belts in problem-solving efforts (Barney, 2002b; Sinha and Van de Ven, 2005). Both MFG and SERV support the importance of connecting multiple levels of the organization together in improvement projects. Various mechanisms in Six Sigma – such as strategic project selection and leadership engagement – help achieve multilevel integration.

5.1.1. Strategic project selection

Six Sigma organizations develop formal mechanisms to select Six Sigma projects. These mechanisms,

sometimes called *project hoppers*, involve senior management to filter out Six Sigma projects that do not have financial or strategic implications (Carnell, 2003; Kelly, 2002; Snee and Hoerl, 2003). From this perspective the decision rights to initiate a project are allocated to senior management. In contrast, other approaches to quality have taken a bottom-up approach where workers directly involved with the process initiate improvement projects. Consistent with Six Sigma, some academic research supports the view that decision rights to initiate improvement projects should be allocated to management (Wruck and Jensen, 1994, 1998). Wruck and Jensen (1994) gave an account of implementing TQM at Sterling Chemicals that resulted in ''team mania'' from an inappropriate allocation of decision rights. Giving management the decision rights to initiate a project helps ensure that project selection is based on strategic importance and not on convenience.

5.1.2. Leadership engagement

Leaders are also involved in the ongoing execution of Six Sigma projects. Senior executive Champions, typically vice presidents, perform many functions for Six Sigma projects, including facilitating project selection, defining project charters, selecting Black Belts and other project resources, removing barriers to project completion, and conducting progress reviews or tollgate reviews with Black Belts (Gitlow and Levine, 2005; Snee and Hoerl, 2003). Tollgate reviews force people to look at what they have been doing and serve as a counterpoint to the freewheeling that can occur in problem solving (Bastien and Hostager, 1988; Weick, 1993). Both MFG and SERV informants noted the importance of ongoing senior executive engagement and support for successful completion of Six Sigma projects.

5.2. Improvement specialists

Both MFG and SERV used *full-time* improvement specialists called Black Belts. Typically, these specialists were trained in the Six Sigma structured method through 4 weeks of training with hands-on experience in improving one or more processes. Many organizations also train most, if not all, employees assigned to projects in Six Sigma basics. These individuals receive 2 weeks of training and are called Green Belts. There are also Master Black Belts who receive extensive training beyond the Black Belt level and whose main responsibilities are to serve as instructors and to provide technical assistance and mentoring (Slater, 1999).

In MFG and SERV, for each Six Sigma project, an improvement team was formed, consisting of employees who had substantial knowledge of the process, served on a part-time basis, and may have had Green Belt training. The team leader was a full-time Black Belt specialist. The Black Belt usually reported to the team's sponsor, the Champion, a member of senior management trained in Six Sigma basics. The Champion provided a holistic view of the organization, helped establish project buy-in, and insured the availability of critical resources to the team.

Both MFG and SERV selected Black Belts not only on the basis of their technical skills but also for their leadership skills. Black Belts play an essential role in Six Sigma because they bridge the gap between senior management and project improvement teams. One can think of a Black Belt as a ''heavyweight'' project manager who reports to higher levels of the organization (e.g., the Champion). A heavyweight project manager can help secure resources and break down barriers, which is critical to a multifunctional team (Clark and Fujimoto, 1991). Heavyweight project managers also help maintain discipline and a vision of the big picture solution as the team explores the problem (Brown and Eisenhardt, 1995). A few organizations (e.g., small companies) do not use full-time Black Belts and instead use part-time project leaders. Also, other organizations use full-time Black Belts but call them by another name, such as ''continuous improvement specialists'' or ''coaches.''

5.3. Structured method

Six Sigma uses a structured method for process improvement, which is patterned after the PDCA cycle (Shewhart, 1931, 1939). The improvement method used at both MFG and SERV was the familiar DMAIC (define, measure, analyze, improve, and control) method.[1] In both SERV and MFG we found a strong emphasis on finding the root cause of the problem through systematic use of the method. The Six Sigma methodology employs standard quality tools such as FMEA, cause-effect charts, and statistical process control (Breyfogle, 1999; Hoerl, 1998; Ishikawa, 1985; Kume, 1985, 1995). These tools include many of the seven classic tools of quality control and the seven new tools for problem formulation and diagnosis (Gitlow et al., 1995; Mizuno, 1988).

[1] MFG also used design for Six Sigma (DFSS) for new products, but that was not part of the data collection reported here.

The structured method is related to the theory of organizational routines. From this perspective the Six Sigma method is a metaroutine, that is, a routine for changing established routines or for inventing new routines. The underlying assumption of metaroutines is that problem solving can follow predicable steps (e.g., DMAIC). The DMAIC method is consistent with the problem-solving steps of the PDCA model and places more emphasis on integrating specific tools into each step of the method.

DMAIC also involves different organizational members at different steps in the method. Champions play an active role in the Define step but a supporting role in the remaining steps. On the other hand, Process Owners take a much more active role in the control step but a supporting role in the other steps. Green Belts tend to take a more active role in the measure, analyze, and improve steps. Finally, Black Belts serve as project leaders and are active in all steps of the process. Prior approaches to quality management have not given this much role clarity to organizational members in each step of the method.

The benefits of the Six Sigma metaroutine go beyond promoting rational decision-making. As one executive at MFG noted:

> Well, what we thought was important is that it [Six Sigma] gives us a common methodology throughout the company. I mean, it's not just to accomplish good results but it's a common methodology for approaching a substantial array of business activities, so on the one hand it's a problem-solving mentality, it's a common methodology, it's common language, it's raising the performance level of a great number of individuals. . . And the other part that we liked is that it could be pervasive, it could be used throughout the company not just in manufacturing but engineering, sales, marketing, and administrative functions. The ability to analyze and solve problems is, of course, an opportunity anywhere in an organization, not just the factory.

This executive highlights the importance of establishing a common language through the metaroutine. The common language serves an integrative function that facilitates diverse team member interaction in exploring system-wide problems. However, getting the benefits of the common language requires institutionalizing the metaroutine across the organization (Scott, 2001).

5.4. Performance metrics

In MFG and SERV we found that Six Sigma used a variety of special metrics, including process sigma measurements, critical-to-quality metrics, financial measures, and strategic measures. The Six Sigma performance metrics were employed at multiple levels of the organization and in service, administrative, and manufacturing processes. Broadly, the metrics can be categorized as customer-oriented metrics or financial metrics.

5.4.1. Customer-oriented metrics

Deming (1986, 1994) and others have stressed the importance of understanding customers' present and future needs when designing new products and services. Understanding the true customer need is at the root of Six Sigma. "A fundamental aspect of Six Sigma methodology is identification of critical-to-quality (CTQ) characteristics that are vital to customer satisfaction" (Evans and Lindsay, 2005, p. 184). The baseline and desired process sigma measure levels are in fact defined relative to customer requirements. As a result, customer requirements help establish project improvement goals and direct improvement efforts of Six Sigma teams (Linderman et al., 2003). Our interviewees at MFG and SERV conclusively stated that determining customer requirements must be part of the Six Sigma process.

5.4.2. Financial metrics

Six Sigma improvement efforts have measurable financial returns that are determined by accountants and financial personnel in the organization. For example, General Electric estimated that for 1999 the impact on net income derived from their Six Sigma efforts minus the implementation costs exceeded $2 billion (General Electric Company, 1999). Most mature Six Sigma companies track their financial results and report the impact to all levels of management on a regular basis.

MFG included a financial analyst on Six Sigma teams. The financial analyst provides an independent auditing function to the team and validates the financial and strategic benefits of the project. The financial analyst's role "is to help translate what the team does into dollars and cents" (Smith et al., 2002, p. 188). The financial analyst can play a role in each step of the Six Sigma methodology (Smith et al., 2002). Upon completion of the project, the financial analyst will continue to track benefits for up to a year to make sure the benefits are realized. SERV did not track financial results as rigorously as MFG, but the company did recognize the importance of connecting Six Sigma projects to financial results.

Prior quality management approaches have made efforts to establish connections between improvement

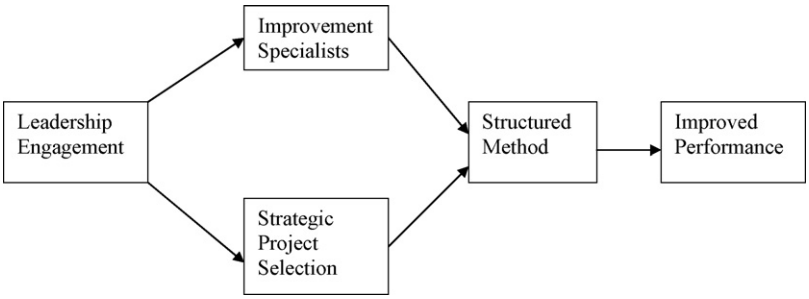

Fig. 2. Proposed mediation model for Six Sigma.

projects and financial performance. For example, Juran (1989) advocated the use of cost-of-quality measures to justify improvement efforts. However, embedding financial analysts into the improvement process is new, and Six Sigma provides a level of financial control not seen in prior quality management approaches.

A measurement orientation at MFG and SERV helped promote ''fact-based'' decision-making. This not only promoted rational decision-making but also helped encourage problem exploration. One respondent shared the adage ''In God we trust, all else bring data.'' This measurement orientation promoted dialog in Six Sigma teams based on expertise and facts rather than positional authority and domination (Eisenhardt et al., 1997). As a result, teams can more effectively explore problems and identify the ''root cause.''

Six Sigma metrics also provide a basis for establishing improvement goals (Linderman et al., 2003). Both MFG and SERV employed improvement goals based on target defects-per-million-opportunities (DPMO) or process sigma metrics. Basing goals on Six Sigma metrics results in specific, challenging goals that can lead to higher levels of performance than do vague, nonquantitative goals such as do-best goals (Locke and Latham, 1990). Clear goals create team alignment, help measure success, and provide a basis for feedback about performance (Ivancevich and McMahon, 1982).

While it is important to have a definition of Six Sigma for future research, there is a belief that organizational performance will improve if the specific practices and parallel-meso organization structure associated with Six Sigma are implemented. Our definition and its related elements need to be tested in practice to determine whether Six Sigma has a direct effect on performance improvement. Toward this end we offer the following proposition.

Proposition 1. *Organizational performance will tend to improve with the use of a parallel-meso Six Sigma structure to reduce variation in organization processes by using improvement specialists, a structured method, and performance metrics with the aim of achieving strategic objectives.*

These Six Sigma elements can be arranged in a framework by the proposed mediation model in Fig. 2. We have shown leadership as a driver of three other elements, and it is an exogenous variable, as is commonly proposed in the literature (Anderson et al., 1994; Kaynak, 2003; National Institute of Standards and Technology, 2006). Leadership should lead to strategic project selection and the use of improvement specialists. These two elements in turn enable the use of the structured method for process improvement. Finally, the structured method leads directly to improved organization performance. From Fig. 2, specific hypotheses can be empirically tested using structural equation modeling or path models.

6. Underlying theory of Six Sigma

Organizations have been characterized as either *mechanistic* in structure, with high levels of standardization, formalization, specialization, and hierarchical authority; or *organic* in structure, with low levels of standardization, formalization, specialization, and hierarchical authority (Burns and Stalker, 1961; Courtright et al., 1989; Scott, 2002). Contingency theory argues that organizations will be more effective if their structure fits their primary task (Donaldson, 2001). From this perspective, the mechanistic structure fits simple and stable tasks and promotes efficiency, whereas the organic structure fits complex and uncertain tasks and supports adaptability. The underlying assumption is that tradeoffs need to be made when selecting a structure. However, some argue for ''dual structures'' from which organizations can realize the benefits of both efficiency and adaptability (Duncan, 1976); this is often referred to as the ambidextrous organization (Tushman and O'Reilly, 1996). Six Sigma

Table 1
Structural control and structural exploration in Six Sigma

Control mechanism	Six Sigma
Structural control	
Outcome	Goals & metrics
Behavioral	Metaroutine Tollgate reviews Decision rights allocation
Social	Organizational socialization
Exploration mechanism	**Six Sigma**
Structural exploration	
Boundary spanning	Multifunctional teams Heavyweight project manager Leadership involvement
Communication	Common language

can be seen as one way to achieve organizational ambidexterity.

Some organizational mechanisms to achieve ambidexterity include job enrichment, contextual ambidexterity, partitioning, and switching (McDonough and Leifer, 1983). Six Sigma can essentially operate as a switching mechanism. Switching mechanisms "create an organic structure when such a structure is needed for the initiation of new ideas" (Daft, 2001, p. 361). "Switching can be supported by 'parallel' organizational structures" (Adler et al., 1999, p. 46).

Some scholars argue that in turbulent environments, organizations need a structure that has both a controlling and an exploring effect (Eisenhardt and Tabrizi, 1995). Research in quality management provides some support for this contention (Douglas and Judge, 2001; Sitkin et al., 1994). In Table 1 we propose that Six Sigma can be viewed from two different structural dimensions: *structural control* and *structural exploration*. Structural control is grounded in control theory (Eisenhardt, 1985; Ouchi, 1979) and helps ensure proper execution of Six Sigma. On the other hand, structural exploration emphasizes boundary-spanning roles (At-Twaijri and Montanari, 1987; Jemison, 1984; Schwab et al., 1985) and communication (Hill and Levenhagen, 1995; Marschan-Piekkari et al., 1999).

6.1. Structural control

Control strategies include outcome, behavioral, and social controls (Eisenhardt, 1985; Ouchi, 1977; Ouchi and Maguire, 1975). Outcome controls regulate activities by specifying the outcomes of tasks (Nidumolu and Subramani, 2003). This requires that the outcomes be measurable (Eisenhardt, 1985). Extensive use of metrics and measurements in Six Sigma help ensure that outcomes are measurable. A number of measures and metrics based on customer requirements, DPMOs, and process sigma measures help establish explicit project goals (Linderman et al., 2003). This creates a "cybernetic process for monitoring and rewarding performance" (Eisenhardt, 1985, p. 135). The focus on financial and non-financial results in Six Sigma also promotes outcome control. For example, on each Six Sigma team MFG embedded a financial analyst who provided an auditing function and clarified the performance outcomes. Such strong measurement and goals employed by Six Sigma support outcome control.

"Behavioral control processes regulate activities by clarifying details of specific behaviors involved in task execution" (Nidumolu and Subramani, 2003, p. 162). These control mechanisms work well when behaviors can be monitored. In Six Sigma the structured method, DMAIC, provides a metaroutine that organizational members follow to solve problems and improve processes. Following a structured method helps avoid jumping to conclusions and helps ensure an adequate search for alternative solutions to a problem. Organizational leaders (Champions) can help monitor and ensure proper execution of the metaroutine by conducting tollgate reviews at each step in DMAIC. Other monitoring mechanisms of the metaroutine can also be used. MFG introduced a Program Evaluation System to monitor the metaroutine. This system did a pre- and postaudit of how the Six Sigma team used the DMAIC process. Teams were rated on the appropriate use of tools and steps within the method, which helped ensure proper execution of the prescribed tools and method. The metaroutine also helps establish role clarity in the improvement process. Champions are more directly involved in the define step, whereas Process Owners take a more active role in the control step, and Black Belts and Green Belts are more actively engaged in the remaining steps. Establishing clear roles and responsibilities helps ensure the execution of the improvement process and avoids having things fall through the cracks. Finally, strategic process selection in Six Sigma allocates decision rights to different organizational members in the improvement process that promotes control. Senior managers decide which improvement projects to select (via the project hopper), whereas Black Belts and Green Belts decide how to make improvements.

Finally, social controls, sometimes called "clan mechanisms" or "culture control" (Ouchi, 1979), can

also provide control when neither outcomes nor behaviors can be clearly observed. Ouchi (1979) gives an example of social control in healthcare (a context where outcome and behavior is difficult to monitor) where, he observes, practitioners undergo "a highly formalized and lengthy period of socialization during which would-be-doctors are subjected to not only skill training but also to value training and indoctrination" (p. 837). Extensive training of Six Sigma specialists not only provides organizational members with important skills but also promotes organizational socialization (Ashforth, 1997; Bauer et al., 1998). Recall the adage "In God we trust, all else bring data." Part of the training in Six Sigma essentially socializes organizational members to the value of fact-based decision-making (Detert et al., 2000). Black Belts at both MFG and SERV demonstrated strong commitment to quality values. The extensive level of training in Six Sigma should allow for more socialization in quality values that was not seen in prior quality management efforts.

6.2. Structural exploration

Structural exploration helps Six Sigma teams be open to and flexible regarding new and different perspectives. Traditionally, organizations have maintained buffers or boundaries to separate functional areas to promote efficiency. GE popularized the boundaryless organization through its Work-Out program (Ulrich et al., 2002). Boundary-spanning roles can help break down barriers that get in the way of problem understanding (Daft, 2001). Research indicates that individuals strongly linked to the external and internal environment are more effective at boundary spanning (Druskat and Wheeler, 2003; Tushman and Scanlan, 1981). In Six Sigma the Black Belt serves as a heavyweight project manager who reports to senior management. This structure promotes boundary-spanning activities that help employees understand and solve problems that cut across functional domains. In contrast, as noted by Lawler (1996), Quality Circles did not provide this type of support structure.

Communication can also facilitate exploration and boundary-spanning activities (Manev and Stevenson, 2001). Since Six Sigma employs multifunctional teams, communication challenges can occur between diverse organizational members, who may have different interpretative schemes that can obstruct understanding (Dougherty, 1992). However, as one executive at MFG noted, institutionalizing Six Sigma creates a common language and method for solving problems. This common language helps overcome barriers created by diverse interpretive schemes. For example, when a financial analyst and an engineer use the term "process sigma" they have a common understanding of what this term means.

Proposition 2. *Higher levels of simultaneous structural control and structural exploration in Six Sigma tend to result in higher organizational performance.*

Incorporating structural control with structural exploration helps resolve some problems with prior quality management approaches (e.g., Quality Circles and TQM). Some elements of Six Sigma have features that support both structural control and structural exploration. For example, instituting the Six Sigma metaroutine helps maintain behavioral control while also establishing a common language. Thus, we believe that implementing both structural control and structural exploration will lead to higher performance levels.

7. Discriminating Six Sigma from TQM

Understanding Six Sigma requires identifying what is new about it, if anything, compared to prior quality management approaches. Various quality frameworks and approaches could be used to determine what is new in Six Sigma, including the Malcolm Baldrige National Quality Award (NIST, 2006), ISO 9000 (Tsiakals et al., 2002), TQM (Kaynak, 2003), Deming (1986, 1994), Juran (1989, 1995), and Crosby (1979), etc. One can view Six Sigma as an approach that can be used within the Baldrige framework as one way to proceed (Byrne and Norris, 2003). However, because the Baldrige framework is not prescriptive in nature, a Baldrige comparison would not by itself determine what is new During the 1990s TQM was the dominant theoretical and empirical paradigm for quality management and included many of the elements advocated by leading quality thinkers such as Deming, Juran, and Crosby. Therefore, TQM seems to be an appropriate – though not the only – basis for comparison with Six Sigma.

Discriminating Six Sigma from TQM has been widely debated. Some would argue that Six Sigma is the latest banner of TQM (McManus, 1999). Others claim that Six Sigma is something new (Pande et al., 2000). In order to compare Six Sigma to TQM, we must first establish a baseline definition for TQM.

Many studies have been done on TQM's definitions and its links to performance (Douglas and Judge, 2001; Flynn et al., 1995; Kaynak, 2003). While we cannot review all of these studies, we will draw on literature reviews and current studies to define TQM.

Recently, Kaynak (2003) compared 18 studies of TQM definitions and their relationship to performance. While some of these studies use a single construct definition of TQM, many of them present TQM as a multi-dimensional construct. Table 2 shows five different studies from the Kaynak paper that have gained wide use in the literature for their definitions of TQM. In the left column of the table are the dimensions of TQM that are common to most, if not all, of the five studies. As can be seen, with the exception of product/service design that is common to three of the five studies, the other dimensions are common to four or all five of the studies. Table 2 also provides a description of the TQM elements taken from the various studies that can be used for direct comparison to Six Sigma.

The first element for comparison is product/service design. While we did not emphasize this element in this paper, it is an important part of design for Six Sigma (DFSS). Both TQM and Six Sigma stress the importance of cross-functional design, customer input, design for manufacturability, robust design, and quality function deployment (QFD). What is different is that DFSS emphasizes following a structured method in design projects. In MFG this process was being taught to all design engineers and provided a common language for both design and certain design tools. The method MFG used for design was IDOV (identify, design, optimize, verify), which functions as the method for product design (similar to DMAIC for process improvement). Thus, the Six Sigma design process is more prescriptive in nature than TQM.

In TQM the area of process management stresses clarity of process ownership, less reliance on inspection, statistical process control (SPC), total productive maintenance (TPM), and process definitions (Flynn et al., 1994). Six Sigma takes a somewhat different approach by stressing process improvement through the use of DMAIC or a similar metaroutine for improvement. While SPC and other tools are part of this process, Six Sigma connects specific tools with specific steps in the process. Similarities with TQM are Six Sigma's process ownership and clear process definitions.

Top management leadership is essential to both TQM and Six Sigma (Harry and Schroeder, 2000; Kaynak, 2003). One difference, however, is the well-defined meso structure in Six Sigma that demands more involvement of leaders on improvement projects. In addition, Six Sigma engages leaders in the improvement process on an ongoing basis. Champions, for example, help direct and support improvement projects.

Training for quality is dramatically different between TQM and Six Sigma. In TQM, training is typically provided for all employees in a 1-week TQM course (Saraph et al., 1989). In both MFG and SERV, Six Sigma training was provided on an as-needed basis and differentiated by task. Likewise, a different approach is used for employee involvement and participation. In TQM, teams are typically formed within work groups or sometimes with cross-functional membership (Flynn et al., 1994). One objective of the TQM team is to involve all employees, frequently at the shop-floor level or in the workplace. In Six Sigma, projects are designated at a strategic level, and teams are formed along process lines to improve a particular process. There is no objective of wide team participation. Furthermore, salaried workers are more likely to be on teams than hourly workers, since many processes are transactional, administrative, or service in nature, or they require engineering skills for improvement. Six Sigma teams are disbanded after the process improvement is implemented, unlike TQM teams, which often have an ongoing charter for improvement in their work areas.

Quality data and reporting under TQM is oriented toward use of cost of quality data, feedback of quality data to the employees, visual display of quality information and benchmarking (Ahire et al., 1996). Six Sigma quality data focuses on customer and financial performance metrics for each specific project. In addition, tracking cost savings on a project-by-project basis has replaced the organization-wide ''cost of quality'' calculations from TQM approaches.

Supplier management is an important element of TQM. It is argued that long-term relationships, a relatively small number of dependable suppliers, and supplier involvement in design contribute to quality improvement (Dow et al., 1999). In contrast, the Six Sigma efforts we studied in MFG and SERV involved suppliers only if the supplier was a critical part of the process being studied.

Finally, customer focus from Table 2 can be seen as an important element of TQM. It is also important in Six Sigma and is given similar emphasis. In both TQM and Six Sigma customer input is important at two levels: the organization and the project level. At the organization level, customer input is critical in establishing which processes and products are in need of strategic improvement. At the project level, customer input is critical in defining those quality attributes that are critical-to-quality and therefore constitute a defect.

Several distinctive features of Six Sigma are illustrated in the above discussion. First, Six Sigma is not distinctive by insisting on top management leadership or in being customer driven. These elements are

Table 2
Definitions of TQM

TQM quality elements	Descriptions of quality elements	Saraph et al. (1989)	Flynn et al. (1994)	Ahire et al. (1996)	Dow et al. (1999)	Douglas and Judge (2001)
Product/service design	Cross-functional design, customer input, design for manufacturability, robust design, use of QFD	Product/service design	Product design: new product quality; interfunctional design process	Design quality management		
Process management	Clarity of process ownership, less reliance on inspection, SPC, TPM, process definition	Process management	Process management: cleanliness and organization	SPC usage		Total quality methods
Top management leadership	Clarity of quality goals, strategic importance of quality, quality priority in performance evaluation, resource allocation for quality, acceptance of quality responsibility	Management leadership	Top management support: quality leadership; quality improvement rewards	Top management commitment	Shared vision	Top management team involvement: quality philosophy
Training for quality	Provision of statistical training, quality training for all employees	Training		Employee training	Personnel training	TQM training
Employee involvement and teamwork	Participation by all on quality teams, employee recognition for quality, employee responsibility for quality, suggestion systems, employee involvement	Employee relations	Workforce management: selection for teamwork potential; teamwork	Employee empowerment; employee involvement	Workforce commitment; use of teams	Continuous improvement
Quality data and reporting	Use of cost of quality data, feedback of quality data to employees, visual display of quality information, benchmarking	Quality data and reporting	Quality information: process control; feedback	Internal quality information usage: benchmarking	Use of benchmarking	Management by fact
Supplier quality management	Long-term relationships, fewer dependable suppliers, reliance on supplier process control, supplier involvement in design	Supplier quality management	Supplier involvement	Supplier quality management	Cooperative supplier relations	
Quality department		Role of quality department				
Customer focus	Customer requirements input, feedback of customer sat		Customer involvement	Customer focus	Customer focus	Customer driven

important in every type of quality management initiative (Juran, 1989, 1995). However, Six Sigma provides a well-defined organizational structure that facilitates leadership engagement.

Differences between Six Sigma and TQM can be succinctly summarized as follows:

1. The focus on financial and business results is to some extent unique. Deming (1986) warned against focusing on results and instead preferred a process focus. On the other hand, the Baldrige Award and related quality awards around the world have focused extensively on results (NIST, 2006). The difference is that Six Sigma usually requires financial returns from most projects and from each full-time Six Sigma specialist. Thus the financial focus is at the project level, in contrast to being on the organizational level in TQM and the Baldrige award. In addition, results are tracked on a pre-project and post-project audit basis by the financial organization. This aggressive insistence on a financial return from improvement projects is new to most organizations. However, Six Sigma recognizes that not all projects produce short-term financial returns; therefore, projects with purely strategic value may also be undertaken (Pande et al., 2000).

   Many of our interviewees emphasized that having strong financial measurement was new compared to past quality efforts. For example, one executive in MFG said:

   > My expectation was that it [Six Sigma] would go the same path that all the other quality initiatives have gone down. You really have to have some ongoing demonstration that it's making a difference... We are very, very strict in our interpretation of this tie and this connection... And we are continuing to demonstrate that we can produce results, which, more than anything else, the evidence that this program produces results, it will keep it going.

2. Use of a structured method for process improvement or new product and service introduction is also not entirely distinctive. However, the degree of insistence on following the structured method, the intense training of the full-time specialists (see Snee and Hoerl, 2003 for discussion of Six Sigma training), and the full integration of statistical and nonstatistical tools are unique. In the past, quality improvement teams have been formed with minimal training (perhaps 1 week or less) and set out to improve a process with less emphasis on the use of data or a well-structured method (Pande et al., 2000). Often these teams were formed more for employee involvement than for improvement. So the intensity of using the specialized method is worthy of note. One executive at SERV said:

   > Six Sigma brings together a very cohesive and comprehensive approach to problem solving. It kind of brings together a number of the better methods and tools that I know and then combines them in a novel way to look at things.

3. Use of specific metrics is also new with Six Sigma. Processes have not been measured in terms of their DPMO, critical-to-quality (CTQ), or process sigma. The effect of these measures highlights the importance of improvement and encourages difficult but attainable goals for improvement. Stretch goals motivate team members to think "out of the box" (Breyfogle, 1999; Hamel, 2000). Six Sigma requires a disciplined approach toward measurement and improvement that has not been evident in previous quality improvement efforts. Six Sigma metrics also help ensure a customer focus when engaging in process improvement efforts. As one executive at SERV noted, "to actually be able to calculate a sigma you have to have a very specific focus on the customer."
4. Finally, the use of a significant number of full-time improvement specialists in Six Sigma is new to many organizations. In the past, organizations were reluctant to make the investment in full-time specialists and often assigned improvement tasks to already overworked staff on a part-time basis. Some organizations used full-time specialists but provided little or no training in structured improvement methods. By contrast, in 1997 GE invested $250 million in training nearly 4000 Black Belts and 60,000 Green Belts out of a workforce of 220,000 employees (Harry and Schroeder, 2000). This large investment paid off in 1997 alone by adding $300 million to net income. Since investments are converted immediately to bottom-line results, management is able to justify the commitment of extensive training and full-time employees.

Overall, much of what is being done in Six Sigma is not entirely new with respect to prior quality tools or principles, but the deployment approach and emergent structure of Six Sigma are new. Six Sigma has been attractive to many CEOs and executives precisely because it is a very disciplined approach with a parallel-meso organization structure that delivers a verified

financial return (e.g., see Slater, 1999). As a result, organizations may find that Six Sigma fits their improvement needs better.

This discussion of differences between Six Sigma and TQM suggests that Six Sigma can be discriminated from TQM in the critical elements described above. Furthermore, we expect that these differences will further improve performance in organizations that have already implemented TQM.

Proposition 3. *Six Sigma will differ from TQM practices as described herein and will tend to provide incremental benefits in customer service and financial results for organizations that have already implemented TQM.*

8. Research directions

There are several directions that future research can take. One of them is testing the above propositions. Also an important issue is investigating what types of organizations are likely to successfully adopt Six Sigma. It seems that there are at least three contingencies regarding Six Sigma that could be tested via contingency theory (Benson et al., 1991; Sousa and Voss, 2001).

1. Most, but not all, companies track financial results from each project. At SERV, for example, they were tracking improvement in customer satisfaction rather than dollars saved. Perhaps certain industries might not be as interested in tracking financial savings as others.
2. Most, but not all, companies use full-time Black Belts to lead projects. At MFG we found that Black Belts were not used in design for Six Sigma, since engineers were already assigned to projects full-time.
3. Employees involved in the projects we studied varied in their use of statistical tools and in their rigor at following all the steps of DMAIC. This tended to be true when the root cause for improving the process was known in advance or when there was a lack of data.

There are no doubt other contingencies that can be specified and tested. This would stand in contrast to those who argue ‘‘one size fits all.’’

Another interesting research project would be to study the benefits that actually accrue from Six Sigma. While project savings can be totaled, they might not translate into organizational savings or improvements in the bottom line. There is also the question of how to measure savings from design projects when the major benefit is cost avoidance. Also, there is no established methodology for measuring revenue enhancements that occur from improved customer satisfaction or increased market share.

Internal fit could be another area of interesting research. The culture of the organization, along with its structure, might be averse to implementation of Six Sigma and thus require changes in the shared values of the employees and in the structure of the company (Eckes, 2001). An aversive culture could inhibit the implementation of Six Sigma and may ultimately defeat it, particularly if there is CEO turnover. The study of Six Sigma sustainability is closely related to the question of internal fit.

Six Sigma is an organizational learning process and one that results in greater knowledge. Viewing Six Sigma through the lens of knowledge management and organizational learning can lead to insights about how to create, retain, and diffuse knowledge using a structured approach (Choo et al., 2007; Lapré et al., 2000).

Finally, we suggest that Six Sigma be viewed as an organization change process. This might provide improved ways for implementation of the Six Sigma process and a more enlightened analysis of what needs to be changed. It might also improve management of the change management process itself. There is certainly ample literature about organizational change that could be used as a starting point (Van de Ven and Poole, 1995).

9. Conclusions

We have proposed an emergent base definition of Six Sigma and an initial theory based on a grounded theory approach. Although Six Sigma builds off prior quality management practices and principles, it offers a new structure for improvement. The structural differences simultaneously promote both more control and exploration in improvement efforts. Some organizations may find benefit from the Six Sigma approach because it fits their organizational needs better.

Academics need to better understand Six Sigma so that they do not overhype it or too quickly dismiss it as nothing new. By better defining and adequately understanding Six Sigma, scholars can develop a deeper and richer knowledge of this phenomenon.

Our research makes four contributions:

1. It proposes a rigorous base definition of Six Sigma from the literature and field study that can be used for further research. A phenomenon cannot be scienti-

fically studied until it is defined; therefore, we provide a starting point for future research on Six Sigma.
2. We provide an underlying theory for Six Sigma research derived from observation and the literature. The theory includes the concepts of ambidextrous organizations, parallel-meso organization, structural control and structural exploration.
3. We suggest well-grounded propositions and a framework for future empirical testing.
4. We differentiate Six Sigma from TQM and other quality management approaches in order to indicate what is new about this approach.

There are some limitations to our research, including the fact that grounded theory has inherent weaknesses. The theory we have developed might require further refinement, but this is a normal part of the theory development and testing process. Nevertheless our grounded theory has a reasonable chance for empirical verification and a better chance than theory developed without the triangulation methods and grounded theory approach used here.

The choice of the two companies studied in depth has perhaps limited the results in some ways. For example, neither company stressed cultural change to a large extent. Eckes (2001), for example, stresses the importance of cultural change along with technical change in an organization, and he proposes a comprehensive approach to cultural change.

Finally, only MFG stressed the use of Six Sigma as a leadership development program in the company. MFG selected from among its best people, trained them as Black Belts, and assigned them to challenging processes in need of improvement. They also trained everyone in the company who was assigned to projects at the Green Belt level and clearly viewed Six Sigma as a way to train, reward, and promote future leaders.

As we go forward in Six Sigma research, it is an opportune time to begin testing the theory that has been developed. This will require random sampling to empirically test and validate the propositions and theory provided. Such theory testing should add to our scientific knowledge regarding Six Sigma and can either verify or refute certain key elements of the definition and theory proposed here.

We have also specified a number of additional research projects using contingency theory, organization learning, and organization change theories. It is only through academic research that a better understanding of Six Sigma can be developed. We hope that this initial effort will provide a beginning for future scientific research and a better understanding of this important phenomenon.

Appendix

Six Sigma elements obtained from interviews

Parallel-meso structure
Strategic project selection
Master Black Belt then would be supporting the Champion, would be involved in project selection-project identification, project selection, matching projects to Black Belts, making sure that we're making the best utilization of the Black Belt resources for those Champions and for their specific critical business objective
. . .projects . . . [should be] . . . selected by the system that we like to have projects selected by
. . .the . . . project, that was selected based on what's the greatest opportunity for hard savings based on what's the opportunity available within this functional area
. . .project selection . . . The ideal model is that you have a flow down from a top level corporate objective. Here's the seven key objectives for MFG. And within those objectives, each of the business unit leaders have a set of those that support these corporate goals. His goal should roll down within his department and when they come to a level when they complete those individual goals, there is a definite tie back to or setting individual goals, there is tie back to the corporate goals
Leadership engagement
There are two significant things. The most significant from my point of view is the buy-in of senior executives. They said we're going to go do this, this is rational. The second thing is . . . we really are measuring hard savings very, very tough. And we are continuing to demonstrate that we can produce results . . . the evidence that this program produces results . . . will keep it going
. . .they are almost all tools that we used in TQM and these are not new. There is a rigor to this deployment that is probably better than the others. There is a top-down engagement to this process
. . .business unit Champion who owns segments of the total Six Sigma commitment in terms of how many projects, how many dollars in hard savings, and how many Black Belts should that employ and how green belts training going.
Performance metrics
Customer metrics
Does your customer perspective help you to learn more about a solution? Sure. I like to put myself in their shoes and [think] if I were them and I saw this process change coming. . . I want to make sure that that's not going to impact me negatively

Appendix (*Continued*)

. . .let me just step back to the voice of the customer process . . . if that's integrated and robust . . . there's a huge amount of knowledge and information that the customer is bringing in. So it's not only . . . complaints, which are valuable information, but it's also like do you have this product, or do you have this feature or that? Or when the sales force is out there and they see a product in the field. [The customer] may modify a car door handle [or] an aircraft engine, and we see that and [bring] back that information on the customer—that ties back into new products. So once again, that strategic element is tied in to define the opportunity and then [we] use the methodology, whether it's like a DMAIC or our CPI methodology or a DFSS/DMADV methodology to drive the new product design

Financial metrics

. . .what really distinguishes it or makes it different [from other quality movements] . . . is the heavy tie to the customer and the financial focus

I don't recall in the TQM initiative that there was any reporting of [the metrics] in the monthly operating results . . . it was not part of every functional organization's monthly results [to answer] how are you doing? And that is a significant part of the commitment of the executives

[The] problem I'm having with my transactional or administrative deployment is . . . because most of them aren't measured, the senior executives didn't buy in to it can have a significant impact

Improvement specialist

What's unique about it? We take people out of their full-time jobs, we take some of the best people. We don't take good old lazy Joe or Sally who are the retreads and ought to be retired. We take some of the more energetic, more dynamic, more hungry people. We take them out of their full-time jobs and give them 4 weeks of training and we send them back working with VPs on solving the biggest problems the company has. And that's really unique . . . we train these lead superstars and plant the seed that those guys in the end will be the leaders of the company

So you give these guys full-time to go drive the methodology and it works. You see clear improvement from it . . . the teaching is nothing different. The methods of solving problems is nothing unique, but it's . . . the dedicated resource and the connection with the Champion that makes this thing really successful

People think Six Sigma is all about Black Belts, but it's not. It's all about Green Belts. And we're using the Black Belts as kind of the front end people to get trained and get visible successes

I think it's extremely helpful to have full-time Black Belts working on projects and the training involved. I think many other quality initiatives do not use people with that much training or that have a full-time dedication. And that I do think is a critical issue and that could be a big difference in success rates too

Well, I think that first of all, having a dedicated Six Sigma Black Belt person facilitating the team, driving the team, that that was a success factor. Oftentimes, you form teams and there are people who have other jobs and so therefore the project becomes the last thing that gets addressed. This being my job [as a Black Belt], I have to address it

Structured method

What's unique about it is the methodology. How to apply the tools. For example, if I taught you how to cut a board . . . when I tell you now go and take out [the] windows in my lake house and install a sliding glass door, you wouldn't [be able to] do that because you need more than just the skill in how to use the saw. You need the methods as to how to apply it and that's [the difference] with six sigma. Having the skill is one thing but knowing how to apply it is the really important part

So it's the methodology plus the tools that we teach you. [The] roadmap is kind of important in the grand scheme, and every week of training you cover the roadmap [and] that's . . . the checklist

I think the unique thing about Six Sigma is that it gives you a platform and a methodology to follow to be consistent and make sure that you've touched all the bases

I think the processes help hold the team together to get consensus. Any project team, any project leader can do that if they're a good project leader. But the tools that we use made it very quick, very easy to get consensus because we've go our facts and data to look at

I think the methodology is probably 50% of the improvement, the individual is probably 25%, and the Champion and the project combine for the other 25%. That's just a guess. But I think the methodology is the strong contributor here, the primary contributor. And that's why it's important to train everyone in the company

My perspective, I guess, on Six Sigma is that it's a good set of methods to reduce defects, improve sigmas, reduce variability in a very methodical way. And I think the reason – a lot of the reason – why it's successful is that it forces a company to dedicate resources to a project

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